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(54) **TRANSFORMER MODULE FOR ELECTRIC VEHICLE**

(71) Applicant: **LSIS CO., LTD.**, Anyang-si, Gyeonggi-do (KR)

(72) Inventors: **Jong In Sun**, Incheon (KR); **Woo Sup Kim**, Seoul (KR); **Bo Hyun Youn**, Seoul (KR); **Chun Suk Yang**, Seongnam-si (KR)

(73) Assignee: **LSIS CO., LTD.**, Anyang-si (KR)

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H01F 27/06	(2006.01)

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(58) **Field of Classification Search**

CPC H01F 27/06; H01F 27/2866; H01F 2027/065

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See application file for complete search history.

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Primary Examiner — Elvin G Enad
Assistant Examiner — Kazi Hossain
(74) *Attorney, Agent, or Firm* — Lee Hong Degerman Kang & Waimey; Jonathan Kang; Jeffrey Lotspeich

(57) **ABSTRACT**

A transformer module for an electric vehicle is provided. The transformer module includes a bobbin round which a primary-side coil is wound, a printed circuit board, and a secondary-side bus bar disposed between the bobbin and the printed circuit board, wherein a pattern part formed of an electrically conductive material to contact the bus bar is provided on the printed circuit board to electrically connect the pattern part to the bus bar in parallel.

4 Claims, 4 Drawing Sheets

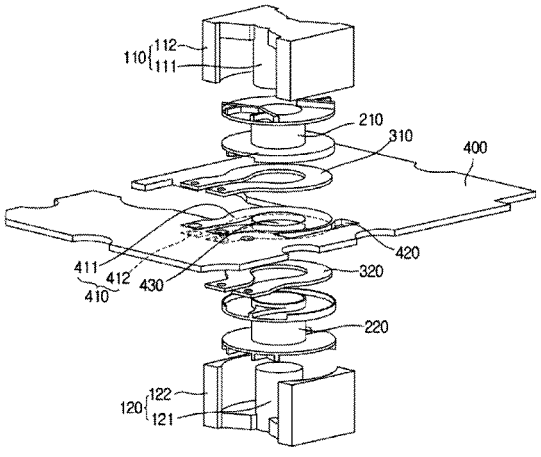

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FIG.1

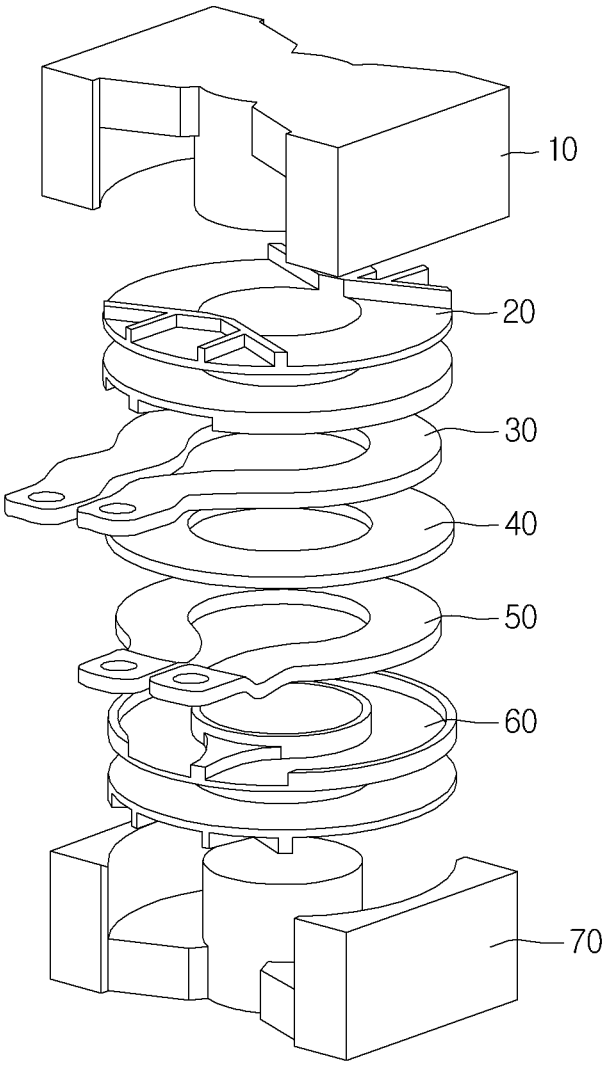


FIG.2

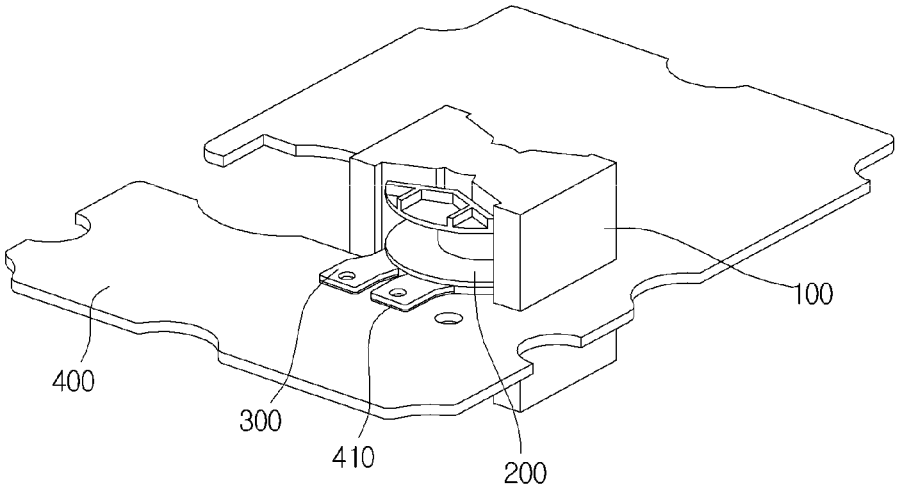


FIG.3

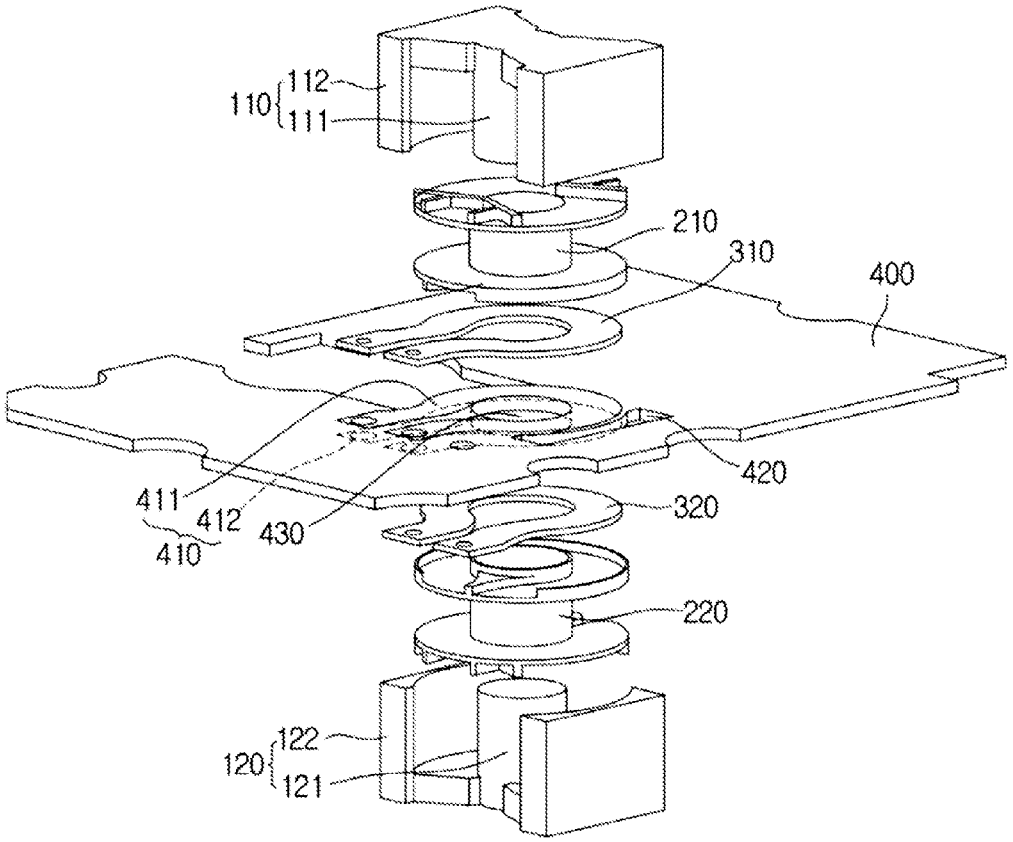
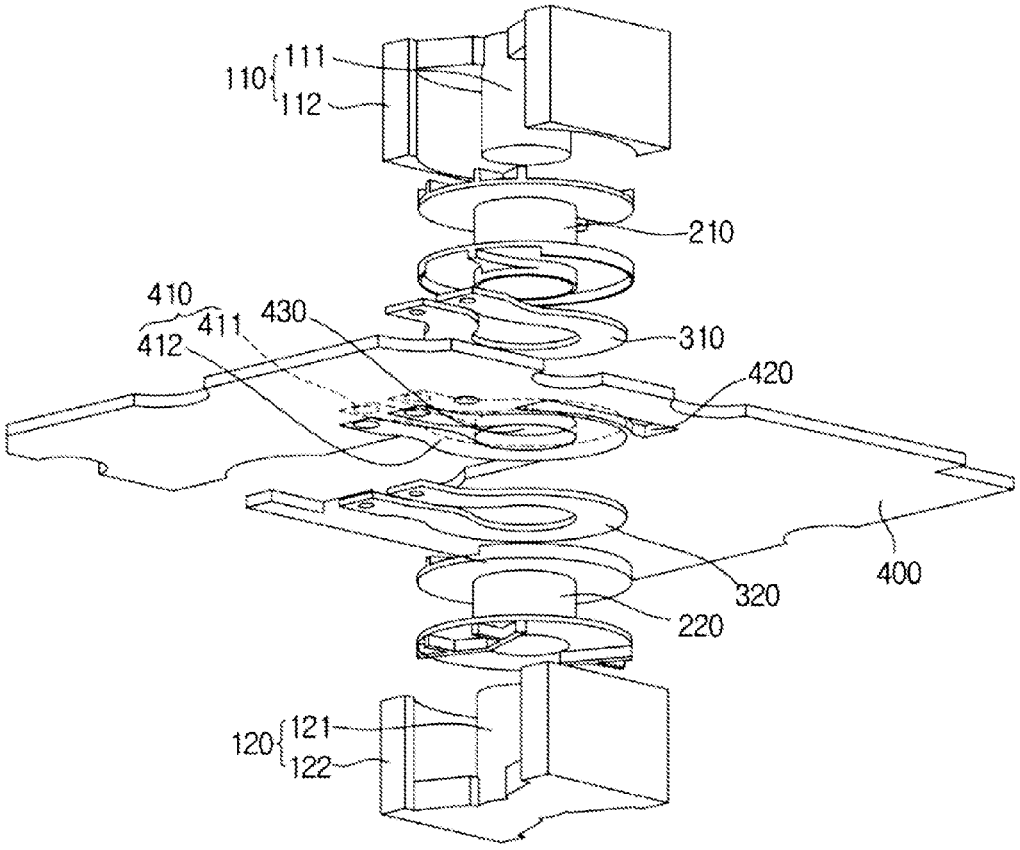


FIG.3A



TRANSFORMER MODULE FOR ELECTRIC VEHICLE

CROSS-REFERENCE TO RELATED APPLICATIONS

Pursuant to 35 U.S.C. §119(a), this application claims the benefit of earlier filing date and right of priority to Korean Application No. 10-2013-0026937, filed on Mar. 13, 2013, the contents of which is incorporated by reference herein in its entirety.

BACKGROUND

The present disclosure relates to a transformer module for an electric vehicle, and more particularly, to a transformer module for an electric vehicle, in which a transformer and a printed circuit board (PCB) are modularized to reduce the number of processes and manufacturing costs in a manufacturing process thereof.

Recently, as the interest in environmental-friendly vehicles has being emphasized due to environmental problems, the expectation for the electric vehicles of the environmental-friendly vehicles is increasing.

Such an electric vehicle includes a transformer as an electronic component.

Generally, transformers are devices which receive AC power from one circuit to supply the AC power to the other circuit by using electromagnetic induction. In the transformers, a voltage is in proportion to a turn ratio of a primary-side coil to a secondary-side coil, and current is in inverse proportion to the turn ratio.

Transformers used in the electric vehicles have to allow high current to flow therethrough, have high efficiency, and be miniaturized to be installed in a narrow space.

FIG. **1** is a perspective view of a transformer used in an electric vehicle according to the related art.

Referring to FIG. **1**, a transformer of an electric vehicle of the related art includes an upper ferrite core **10**, an upper bobbin **20** coupled to a lower portion of the upper ferrite core **10**, an upper bus bar **30** disposed on a lower portion of the upper bobbin **20**, a lower bus bar **50** disposed on a lower portion of the upper bus bar **30**, a lower bobbin **60** disposed on a lower portion of the lower bus bar **50**, and a lower ferrite core **70** disposed on a lower portion of the lower bobbin **60**.

A support **40** having a ring shape is disposed between the upper bus bar **30** and the lower bus bar **50** to prevent mechanical wobble from occurring.

If the above-described constitutions are provided, since each of the upper and lower bus bars **30** and **50** should have a cross-sectional area of a predetermined size or more to allow high current to flow therethrough, the transformer may increase in overall size. Thus, it is difficult to manufacture a small-sized transformer.

In addition, after the transformer including the above-described constitutions is manufactured, the transformer has to move to a separate manufacturing line so as to attach a printed circuit board thereto through an impregnation process. Thus, it is required to develop an effective manufacturing process.

SUMMARY

Embodiment provide a transformer module for an electric vehicle, in which a bus bar is reduced in size to allow the transformer module to be miniaturized, and a printed circuit board (PCB) and a transformer are integrated to reduce the number of assembling processes and manufacturing costs.

In one embodiment, a transformer module for an electric vehicle, the transformer module includes: a bobbin round which a primary-side coil is wound; a printed circuit board; and a secondary-side bus bar disposed between the bobbin and the printed circuit board, wherein a pattern part formed of an electrically conductive material to contact the bus bar is provided on the printed circuit board to electrically connect the pattern part to the bus bar in parallel.

The pattern part may have a shape corresponding to that of the bus bar.

The pattern part may include: an upper pattern disposed on a top surface of the printed circuit board; and a lower pattern disposed on a bottom surface of the printed circuit board, wherein the bus bar may include: an upper bus bar contacting the upper pattern; and a lower bus bar contacting the lower pattern, wherein the bobbin may include: an upper bobbin disposed on an upper portion of the upper bus bar, a lower bobbin disposed on a lower portion of the lower bus bar.

The transformer module may further include a ferrite core, wherein the ferrite core may include: a central part vertically extending from a center thereof; and a sidewall part spaced apart from the central part to vertically extend, wherein a first cutoff part having a shape corresponding to that of the sidewall part vertically may pass through the printed circuit board.

The bus bar may be a plate-shaped member of which a portion of a center has a ring shape, the pattern part may have the same shape as the bus bar, and a portion of a center of the pattern part has a ring shape, and a second cutoff part vertically passing through may be disposed inside the ring-shaped portion of the pattern part on the printed circuit board.

The pattern part may be formed of a material having superior electrical conductivity than that of the bus bar.

The pattern part may be printed on the printed circuit board.

The details of one or more embodiments are set forth in the accompanying drawings and the description below. Other features will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exploded perspective view illustrating a transformer of an electric vehicle according to a related art.

FIG. **2** is a perspective view illustrating a transformer of an electric vehicle according to an embodiment.

FIG. **3** is an exploded perspective view illustrating the transformer of the electric vehicle according to embodiment.

FIG. **3**A is an alternate view of the exploded perspective view of the transformer of the electric vehicle shown in FIG. **3**.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Hereinafter, a transformer module for an electric vehicle according to an embodiment will be described in detail with reference to the accompanying drawings.

FIG. **2** is a perspective view illustrating a transformer of an electric vehicle according to an embodiment, and FIG. **3** is an exploded perspective view illustrating the transformer of the electric vehicle according to the embodiment.

Referring to FIGS. **2** and **3**, a transformer module for an electric vehicle according to the current embodiment is embodied by coupling a transformer to a printed circuit board (PCB) **400** to modularize the coupled transformer and PCB. The transformer may include a ferrite core **100**, a bobbin **200** round which a primary-side coil is wound, and a secondary-side bus bar **300**. A pattern part **410** through which current flows is disposed on the PCB **400** in parallel with the bus bar **300**.

In detail, as shown in FIG. **2**, the transformer module for the electric vehicle according to the current embodiment may include the ferrite core **100**. As shown in FIG. **3**, the ferrite core **100** may include an upper ferrite core **110** and a lower ferrite core **120**.

The upper ferrite core **110** has a cylindrical shape and includes a central part **111** vertically extending downward from a center of the upper ferrite core **110**, a sidewall part **112** provided in a pair on both sidewalls of the central part **111** in a transverse direction. Like the central part **111**, the sidewall part **112** vertically extends downward.

Like the upper ferrite core **110**, the lower ferrite core **120** may include a central part **121** and a sidewall part **122**. The lower ferrite core **120** and the upper ferrite core **110** may have shapes that are vertically symmetrical to each other.

As shown in FIG. **2**, the transformer module for the electric vehicle according to the current embodiment may further include the bobbin **200**. As shown in FIG. **3**, the bobbin **200** may include an upper bobbin **210** and a lower bobbin **220**.

The upper bobbin **210** and the lower bobbin **220** may have shapes that are vertically symmetrical to each other. Each of the upper and lower bobbins **220** and **210** has a cylindrical hollow part in which a central portion of the ferrite core is inserted. A primary-side coil (not shown) is wound round the outside of the ferrite core and connected to a high-voltage battery (not shown) of the electric vehicle.

As shown in FIG. **2**, the transformer module for the electric vehicle according to the embodiment may further include the bus bar **300**. As shown in FIG. **3**, the bus bar **300** may include an upper bus bar **310** and a lower bus bar **320**.

The bus bar **300** may be a plate-shaped member of which a portion of a center has a ring shape. The bus bar **300** has both ends facing the same direction. The bus bar **300** may be formed of a conductive material such as copper (Cu).

As shown in FIGS. **2** and **3**, the transformer module for the electric vehicle according to the embodiment may further include the PCB **400**. The PCB **400** is disposed between the upper bus bar **310** and the lower bus bar **320**.

The pattern part **410** is disposed on the PCB **400**. The pattern part **410** may include an upper pattern **411** disposed on a top surface of the PCB **400** and a lower pattern **412** disposed on a bottom surface of the PCB **400** as shown in the alternate view of FIG. **3**A.

The pattern part **410** may be formed of the conductive material and have a shape corresponding to that of each of the upper bus bar **310** and the lower bus bar **320**.

In more detail, a portion of a center of each of the upper and lower bus bars **310** and **320** has a ring shape, and both ends of each of the upper and lower bus bars **310** and **320** face the same direction. Thus, the upper pattern **411** and the lower pattern **412** may also have the same shape as that of each of the upper and lower bus bars **310** and **320**.

That is, the upper pattern **411** has the same as the upper bus bar **310**, and the lower pattern **412** has the same as the lower bus bar **320**.

The pattern part **410** may be printed on the PCB **400**.

A first cutoff part **420** vertically passes through the outside of the pattern part **410**. The first cutoff part **420** may have a shape corresponding to that of each of the sidewall parts **112** and **122** of the ferrite core **100**. When the transformer and the printed circuit board **400** are assembled as one module, the first cutoff part **420** may be a part in which at least one of the sidewall part **112** of the upper ferrite core **110** or the sidewall part **122** of the lower ferrite core **120** is inserted, or both sidewall parts **112** and **122** are inserted.

A second cutoff part **430** is formed in a central portion of the pattern part **410**. In more detail, the ring-shaped central portion of the pattern part **410** is circularly punched to form a space vertically passes through the pattern part **410**. Here, the space is defined as the second cutoff part **430**.

The second cutoff part **430** may have a shape corresponding to central parts **111** and **121** of the ferrite core **100**. The second cutoff part **430** has the same diameter as that of each of the central parts **111** and **121** or a diameter greater than that of each of the central part **111** and **121**.

In summary again of the arrangement between the above-described constitutions, the upper ferrite core **110**, the upper bobbin **210**, the upper bus bar **310**, the PCB **400**, the lower bus bar **320**, the lower bobbin **220**, and the lower ferrite core **120** are sequentially disposed downward. Here, the central part **111** of the upper ferrite core **110**, the second cutoff part **430**, and the central part **121** of the lower ferrite core **120** are vertically aligned in the same line. Also, the sidewall part **112** of the upper ferrite core **110**, the first cutoff part **420**, and the sidewall part **122** of the lower ferrite core **120** are vertically aligned in the same line.

Also, these constitutions are coupled to each other to constitute one module. As such, when the transformer and the PCB are modularized, the number of parts to be managed may decrease. Thus, when electrical devices of the vehicle are assembled, the number of assembling processes may decreases to quickly assemble the electrical devices, thereby reducing manufacturing costs.

Thereafter, functions of the transformer module for the electric vehicle including the above-described constitutions will be described.

The primary-side coil (not shown) is wound round the bobbin **200** and connected to the high-voltage battery (not shown) having a relatively high voltage. The high-voltage battery is connected to a charging device separately provided outside the vehicle and then charged. For example, the high-voltage battery may have a voltage of about 200 V to about 450 V. Current applied to the primary-side coil (not shown) is delivered to a low-voltage battery (not shown) having a relatively lower voltage through the secondary-side bus bar **300** via the transformer. For example, the low-voltage battery may have a voltage of about 12 V. The low-voltage battery may provide power for operating electrical devices for the vehicle such as a wiper, an audio, a power window, and the like.

Here, the current applied to the low-voltage battery through the secondary-side bus bar **300** flows through the pattern part **410** electrically connected to the bus bar **300** in parallel as well as the bus bar **300**.

Unlike that current flows through only a bus bar in the related art, since the current flows through the bus bar **300** and the pattern part **410**, the bus bar **300** may have a relatively small cross-sectional area.

Also, as the bus bar **300** decreases in cross-sectional area, the bus bar may also decrease in plane area to reduce an overall size of the bus bar.

Here, in a case where the pattern part **410** is formed of a material having relatively superior electrical conductivity than that of the bus bar **300**, the bus bar **300** may further decrease in size.

The reduction in size of the bus bar **300** may enable the transformer to be reduced in overall volume. Furthermore, the transformer and the printed circuit board **400** may be modulated to manufacture more compact transformer module.

According to the embodiment, the transformer may be miniaturized, and the transformer and the PCB may be modularized to simplify the manufacturing process and reduce the number of processes, thereby reducing the manufacturing costs.

In addition, the pattern and the bus bar on the PCB disposed at the secondary-side coil of the transformer may be used at the same time to reduce the volume and the manufacturing costs while increasing current density.

Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

What is claimed is:

1. A transformer module for an electric vehicle, the transformer module comprising:

an upper bobbin around which a primary-side coil is wound;

a printed circuit board; and

an upper bus bar disposed between the bobbin and the printed circuit board; and

an upper pattern part formed of an electrically conductive material provided on the printed circuit board;

wherein the upper pattern part has a shape corresponding to a shape of the upper bus bar and electrically connects to the upper bus bar in parallel,

wherein the upper pattern part is formed of a material having superior electrical conductivity than that of the upper bus bar,

wherein the upper pattern part is printed on the printed circuit board.

2. The transformer module according to claim **1**, wherein the upper pattern part is disposed on a top side of the printed circuit board and the transformer module further comprises:

a lower pattern part disposed on a bottom side of the printed circuit board;

a lower bus bar contacting the lower pattern part; and

a lower bobbin disposed on a lower portion of the lower bus bar.

3. The transformer module according to claim **2**, further comprising a ferrite core wherein the ferrite core comprises:

a central part vertically extending from a center of the ferrite core; and

a sidewall part vertically extending from a position spaced apart from the center;

wherein the printed circuit board comprises a cutoff part opening shaped to correspond to a shape of the sidewall part.

4. The transformer module according to claim **1**, wherein:

the upper bus bar is plate-shaped and comprises a center portion having a ring shape; and

the upper pattern part comprises a center portion having a ring shape, and

the printed circuit board comprises a cutoff part opening passing through the center portion of the upper pattern part.

* * * * *